

ENVIRONMENTAL PROTECTION AGENCY

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SOUTHWESTERN RADIOLOGICAL HEALTH LABORATORY

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Date: January 8, 1971

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bject: Effects of Irradiation on the Thyroid Gland

To: Geneva Douglas
Information Officer

Study Group	Source of Irradiation	Amount Administered: Internal	External Irradiation: Dose to Thyroid	Total Thyroid Dose	Effects (See Att. Sheet).
1. Marshallese people of Rongelap Island	Fallout, 1954 from nuclear test in Pacific	11.2 μ Ci ^{131}I	175 rad	Adults: 160 rad Children: 700-1,400 rad	
2. Children and adolescents treated for thyrotoxicosis	Medically administered isotope	2-32 mCi Average: 6.6 mCi		10-13,000 rad	
3. Rochester subgroup C: children treated with X-irradiation for Thymic enlargement. 268/3,000 had been treated in infancy in a similar manner	X-irradiation from X-ray unit	None	335 rad	335 rad	
4. 1965 Ann Arbor series: 758 children, irradiated in infancy for Thymic enlargement	X-irradiation from X-ray unit	None	20 rad	20 rad	

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<u>Study Group</u>	<u>Source of Irradiation</u>	<u>Amount Administered: - Internal</u>	<u>External Irradiation: Dose to Thyroid</u>	<u>Total Thyroid Dose</u>	<u>Effects (See Att. Sheet)</u>
Survivors of atomic bomb in Hiroshima & Nagasaki.	Primarily external gamma and first collision	?	Uncertain.	?	
NIH-ABCC Life-span Study	neutron irradiation		Dist. from hypocenter	Ave. Dose	
			1,000 meters	500 <i>rad</i>	
			1,400 "	100 <i>rad</i>	
			2,000 "	11 <i>rad</i>	



Effects (Comments):

- A. Study Group 1: Conard, R. A., et al, Thyroid Neoplasia as Late Effect of Exposure to Radioactive Iodine in Fallout. JAMA, Vol. 214 #2 (October 12, 1970)

Thyroid Lesions in Marshallese, March 1969				
Island Group (Radiation Dose-Gamma)	Age at Exposure (yr)	Estimates Thyroid Dose (Rad, Radioactive Iodines*)	Thyroid Lesions (%)†	Malignant Lesions (%)‡
Rongelap (175 Rad)	<10	500-1,400	89.5 (17 of 19)	5.3 (1 of 19)
	>10	160‡	8.8 (3 of 34)	5.9 (2 of 34)
	all	...	39.6 (21 of 53)	5.7 (3 of 53)
Rongelap (69 Rad)	<10	275-550	0.0 (0 of 6)	...
	>10	55	12.5 (1 of 8)	...
	all	...	7.1 (1 of 14)	...
Utirik (74 Rad)	<10	55-100	0.0 (0 of 40)	...
	>10	14	5.1 (3 of 59)	1.7 (1 of 59)
	all	...	3.0 (3 of 99)	1.0 (1 of 99)
Rongelap (unexposed)	<10	...	0.0 (0 of 61)	...
	>10	...	2.3 (3 of 133)	...
	all	...	1.5 (3 of 194)	...

*Dose from 1951, 1952, 1953, 1954.

†Based on number now living.

‡Children 10 to 20 years of age at exposure received doses between 160 and 500 rad.

The highest incidence of thyroid lesions (89.5%) has been noted in the heavily exposed Rongelap children who were less than 10 years of age at time of the accident. In 1965 one case, and in 1969 three cases of malignant lesions were discovered. These recent findings greatly increase the author's concern about radiation-induced neoplasms in the population. "Microscopically the thyroid carcinomas were considered of low grade malignancy..."

The exposure of the Rongelap people was not comparable to exposure of populations from reactor accidents where radionuclides are chiefly absorbed from contaminated milk obtained from cattle grazing on contaminated pastures.

It has been generally believed that radioactive iodine exposure was less effective than X-irradiation in producing thyroid lesions based **primarily on the** fact that few thyroid tumors had been noted following radioactive iodine therapy. It seems likely, however, that the scarcity of such findings is relative to the high doses of radiation used (5 to 10,000 rad or more in the treatment of hyperthyroidism, and 50,000 rad or more used for ablation of the gland to ameliorate symptoms in certain diseases). Such doses are probably so destructive that they preclude proliferative activity and malignant transformation in such damaged glands.

There were some factors secondary to radiation exposure that might have enhanced the development of thyroid disease in the Marshallese. For instance, the development of ten cases of nodular goiter in the children during or near the time of puberty might indicate that this stress may have enhanced nodular development.

- B. Study Group 2: Hayek, Alberto, et al, "Long-Term Results of Treatment of Thyrotoxicosis in Children and Adolescents with Radioactive Iodine," New Eng. J. of Med., Vol. 238, No. 18, (October 29, 1970).

From 1941 through 1968, 30 patients between 8 and 18 years were treated with radioactive iodine for thyrotoxicosis. Two were males and 28 were females. Two received ^{130}I and 28 ^{131}I . Dose of ^{131}I ranged from 2 to a maximal cumulative dose of 32 mCi in two separate doses with an average dose of 6.6 mCi per patient. Mean follow-up observation was 9.2 years.

Recurrence of thyrotoxicosis associated with benign nodular hyperplasia was observed in only one case 17 years after treatments with ^{130}I . Twelve of the females treated with ^{131}I have given birth to 18 healthy children. One woman treated with ^{130}I has an abnormal reproductive history. No deaths, and no evidence of cancer or leukemia were seen.

- C. Study Group 3: Hemplemann, Louis, "Risk of Thyroid Neoplasms After Irradiation in Childhood," Science, Vol. 160 (April 12, 1968).

One hundred five of the 268 were examined initially at ages 17-35. Twenty-three nodular thyroids were palpated versus two in a matched control group. Using statistical methods involving adding a percentage with goiters for the unexamined group they found 28% incidence of nodularity.

- D. Study Group 4: Hemplemann, Louis, "Risk of Thyroid Neoplasms After Irradiation in Childhood," Science, Vol. 160 (April 12, 1968).

At mean age of 29 this population was surveyed by mail and a total of 7 adenomas and one carcinoma were found. Considering the established ratio of 3:1 for clinically palpable versus surgically removed nodules, an incidence of 3% was determined.

- E. Study Group 5: (a) Angevine & Jablon, "Late Radiation Effects of Neoplasia and Other Diseases in Japan," Ann. N.Y. Acad. Sci., 114/2:823-831 (1964).

(b) Socolow, E. L., et al, "Thyroid Carcinoma in Man After Exposure to Ionizing Radiation," N.E.J.M., 268:406-410 (February 21, 1963).

(c) ICRP Publication #14, "Radiosensitivity and Spatial Distribution of Dose," Pergamon Press (1969)

Some valuable information has come out of the ABCC evaluations of those people exposed at the time of the A Bomb. This is true even though dose estimates and patient follow-up have been difficult. Autopsy studies of 1,215 exposed patients (14% of whom were exposed within 1,400 m of the hypocenter, and hence probably received greater than 100 rads) showed 21 thyroid malignancies. The number expected on the hypothesis of no relationship between thyroid cancer and distance is 3. The probability of observing so large an excess by chance is 0.023 (one tail). In only 3 of the 21 was carcinoma considered to have contributed to the death of the patient. The remaining 18 lesions were minute, seldom measuring more than 1.5 cm across, and were usually first recognized on histological exam. They were non-aggressive lesions ("non-encapsulated sclerosing") with an excellent prognosis.

During 1958-61 some 10,780 exposed Hiroshima patients involved in Adult Health Study program were examined, and 310 enlarged thyroids were found. 102 were single nodules, 70 were biopsied, and in the group exposed at distances less than 2,000 m, and who showed acute symptoms at the time of the bomb, 10 had thyroid malignancy.

Conclusions which have been drawn by the ICRP regarding radiation induced thyroid cancer include:

1. A careful distinction between frequency of induction and frequency of death must be made in any discussion of radiation induced thyroid cancer.
2. Due to the limitations of dose estimates and epidemiological techniques, underassessment of the number of cases and overassessment of dose, each lead to an underestimate of the yield of thyroid cancer per rad. It was concluded that as a working rule the total risk in exposed Japanese was about 20-30 cases per rad per million exposed with little, if any, variation with age at time of exposure.

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